## REMARKS

Claims 1-20 are pending in this application. In the Office Action mailed May 22, 2003, the Examiner (1) objected to the drawings under 37 C.F.R. §1.83(a); (2) rejected claims 1-20 under 37 C.F.R. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention; and (3) rejected claims 1-20 under 37 C.F.R. §102(b) as being anticipated by U.S. Pat. No. 5,671,240 to Okazaki. Applicants respectfully traverse these objections and rejections in light of the amendments and remarks below.

Applicants respectfully submit that no new matter has been added to this application.

In the specification, the paragraph beginning on page 8, line 8, and ending on page 8, line 19, has been amended to better describe that a resonator 51 is included in a semiconductor laser unit 11. Support for the resonator 51 can be found throughout the application, e.g., on page 5, line 20. Moreover, the inclusion of a resonator in a laser device is known. Ohtsuka Declaration, page 7, ¶23. The specific construction of the resonator is not essential to the invention. Id. at ¶24, 25. Thus, while the amendment to the drawing improves the clarity of the application, it does not add any new matter.

Additionally, the paragraph beginning on page 11, line 25 and ending on page 12, line 4, the paragraph beginning on page 12, line 15 and ending on page 13, line 7, and the paragraph beginning on page 13, line 8 and ending on page 13, line 26, have been amended to include a numeral reference "51," to denote the resonator included in the semiconductor laser unit 11.

In amended Fig. 1, the previously omitted internal resonator 51 of length L has been added in the laser unit 11. Support for the resonator 51 can be found throughout the application, e.g., on page 5, line 20.

**Introduction**

Prior to addressing the rejections and objections raised in the Office Action, Applicants take this opportunity to set forth the following brief remarks in connection with their invention, which relates to a laser apparatus. As discussed below, it has not been a simple matter to provide a solid-state laser apparatus with high output power and quality. *See* Declaration of Hisashi Ohtsuka dated November 19, 2003 (hereinafter "Ohtsuka Declaration"), page 1, ¶2.

A conventional response to these demands was to use a solid-state laser apparatus with a broad-guide semiconductor laser unit having a high power output. Additionally, as a widespread technique, the laser light was converted into a second harmonic wave by providing a wavelength conversion element in an external resonator arranged outside of the solid-state laser element. *See* Ohtsuka Declaration, page 2, ¶3; *see also* Application, page 1, line 13 - page 2, line 2.

Similarly, in the conventional semiconductor-laser-excited solid-state laser apparati, the excitational light source was driven under a so-called automatic power control (APC), so as to stabilize the laser oscillation. In other words, a portion of output laser light was monitored and fed back to the excitational light source, so as to reduce the variations in the output laser light. *See* Ohtsuka Declaration, page 2, ¶4; see *also* Application, page 2, lines 3-10.

In order to stabilize the output laser light by the automatic power control, it was desirable to have a constant ratio of an increase in the output of the semiconductor laser unit to an increase in the output of the solid-state laser apparatus. In other words, it was desirable that the output of the solid-state laser apparatus monotonously increases with the increase in the output of the semiconductor laser unit. *See* Ohtsuka Declaration, page 2, ¶5; see *also* Application, page 2, lines 10 - 17.

However, in practice, the output of the solid-state laser apparatus did not adequately increase, even when the output of the semiconductor laser unit was increased by 10% or 20%. *See* Ohtsuka Declaration, page 2, ¶6. Indeed, the output of the conventional solid-state laser apparatus reached a level of saturation when the output of the semiconductor laser unit was increased by 8% over an initial driving state. *See* Ohtsuka Declaration, page 2, ¶6; see *also* Application, page 2, lines 21- 25.

The above problem is believed to be caused in part by deviation in the oscillation wavelength of the semiconductor laser unit from a desired absorption peak of the solid-state laser element. *See* Ohtsuka Declaration, pages 2-3, ¶7. Since a great amount of heat is generated by the semiconductor laser unit, the oscillation wavelength of the semiconductor laser unit is highly dependent on the driving current. *Id.* In other words, the oscillation wavelength of the semiconductor laser unit shifted with an increase in the driving current. Consequently, the deviation of the oscillation wavelength of the conventional semiconductor laser unit from the desired absorption peak of the solid-state laser element increased with an increase in the driving current. *Id.* Hence, the excitational light could not be efficiently absorbed by the solid-state laser element, and therefore, even

when the driving current was greatly increased, the increase in the output power of the conventional solid-state laser apparatus was often small. *Id.*

Some in the field have attempted to suppress the dependence of the laser unit's oscillation wavelength on the driving current by enhancing the radiation effect of the semiconductor laser unit. *See* Ohtsuka Declaration, page 3, ¶8. In particular, an attempt has been made to optimize a mechanical member which fixes a semiconductor laser unit so as to enhance radiation efficiency and reduce the dependence of the laser unit's oscillation wavelength on the driving current. *Id.*

However, this optimization of the mechanical member was determined to be insufficient to reduce the dependence of the oscillation wavelength on the driving current at increased output powers. *See* Ohtsuka Declaration, page 3, ¶9.

Even the attempts to prevent the deviation of the oscillation wavelength did not fundamentally improve the characteristics of the semiconductor laser apparatus. *See* Ohtsuka Declaration, page 3, ¶10. Therefore, output loss was occurring in the solid-state laser apparatus, thus preventing further increase of the output power. *Id.* Hence, attempts in the past suffered from a common drawback in that they did not provide a semiconductor-laser-excited solid-state laser apparatus in which stable automatic power control could be performed, and from which stable, high-power, laser light was output.

The semiconductor laser apparatus device according to the present invention overcomes the shortcomings of the prior art, in that it provides a laser apparatus that includes a laser unit having an internal resonator of at least 0.8 mm, where the length of the internal resonator is dependent upon a characteristic of a solid-state laser element used in the laser apparatus.

The invention is not merely a laser unit with an internal resonator. *See* Ohtsuka Declaration, page 4, ¶12. Laser units with conventional internal resonators, but not in combination with semiconductor elements in a laser apparatus as claimed, are known. *See* Ohtsuka Declaration, p. 11, ¶23 (including, as Exhibit 1, a Japanese article, the relevant portion of which describes a conventional laser unit with an internal resonator having a length of 300 μm). Rather, the present invention is a laser apparatus with a laser unit that includes an internal resonator having certain properties as specified in the claims. *See* Ohtsuka Declaration, page 4, ¶12.

**Objection to the Drawings**

The Examiner objected to the drawings under 37 C.F.R. §1.83(a). In particular, the Examiner has argued that the solid-state resonator and the internal resonator of claim 4 must be shown in the drawings, or the features canceled from the claims. The solid-state resonator 31, however, has already been shown in Fig. 1, as a rectangular box housing a solid-state laser medium 13, a resonator mirror 14, quarter wave plates 15 and 16, an optical wavelength conversion element 17, a polarization control element 18 and a wavelength selection element 19.

Applicants have also amended Fig. 1 to include the previously omitted internal resonator 51 of length L. Support for the resonator 51 can be found throughout the application, e.g., on page 5, line 20.

It would be known to those of ordinary skill in the laser art how to make a conventional internal resonator used in a conventional semiconductor laser unit. Ohtsuka Declaration, page 7, ¶25. Therefore, a detailed illustration of the internal structure of the

resonator in the semiconductor laser unit is not essential for a proper understanding of the invention, and a graphical drawing symbol representing the internal resonator should be sufficient. *See* 37 C.F.R. §1.83(a).

In light of these remarks and amendment to Fig. 1, the applicants respectfully submit that the Examiner's objection to the drawings is now moot.

**Rejection of Claims 1-20 Under 35 U.S.C. §112, ¶2**

Claims 1-20 have been rejected as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention. In particular, the Examiner pointed out that claims 1 and 4 were incomplete for omitting essential elements, namely for failing to define the structure of the internal resonator, which the Examiner alleged to be "essential to the claimed invention." Furthermore, the Examiner pointed out that, with regard to claims 7, 12, 14 and 19, it was not clear within the claim language how the absorption band was detected or determined, as no structure had been recited for the laser system to perform such a function. Reconsideration of this rejection is respectfully solicited in light of the following remarks.

Independent Claim 1, and Claim 4 which depends therefrom, recite a semiconductor laser unit that includes an internal resonator having a length of at least 0.8 mm, the length being dependent upon a characteristic of a solid-state laser element. Support for the corresponding claim language can be found, e.g., on page 5, lines 17-24, and page 14, lines 8-13. Additional support for the language of Claim 1 can be found throughout the specification and figures, e.g., Figs. 1-3.

The specific construction of the internal resonator and its structure are not essential to the claimed invention. Ohtsuka Declaration, page 7, ¶24. "Essential material" is defined as that which is necessary to (1) describe the claimed invention, (2) provide an enabling disclosure of the claimed invention, or (3) describe the best mode. M.P.E.P. 608.01 (P)(I)(A).

As previously pointed out, it would be known to those of ordinary skill in the laser art how to make a conventional internal resonator used in a laser unit. Therefore, it would be known to make such a device as specified in the claims and included in the claimed system. Ohtsuka Declaration, page 7, ¶25. Thus, the internal structure of the resonator in the semiconductor laser unit is not necessary to either describe the claimed invention, provide an enabling disclosure, or describe the best mode.

However, what would not be known is to use the laser unit that includes an internal resonator 51 having a length of at least 0.8 mm, the length being dependent upon a characteristic of a solid state laser element 13, as claimed in independent claim 1, and claim 4 which depends therefrom. Ohtsuka Declaration, page 7, ¶26. These characteristics of the internal resonator 51, according to the present invention, are sufficiently described in the application so as to enable those of ordinary skill in the art to practice the invention. (See, e.g., Application, p. 8, line 8 - p. 14, line 19, and corresponding Figs. 2-3).

In view of the foregoing, it is submitted that the internal resonator and its structure need not have been defined and depicted since it would be known how to make such an internal resonator and the novel characteristics according to the present invention are sufficiently described in the specification.

Regarding claims 7, 12, 14 and 19, they are directed to a semiconductor-laser-excited solid-state laser apparatus that includes, *inter alia*, a solid-state laser element 13 and a laser unit 11 having an internal resonator 51. As claimed, e.g., in claim 7, the length of the internal resonator 51 depends on an absorption band of the solid-state laser element 13. The absorption band is an inherent characteristic of the solid-state laser element in question and, thus, the structure for detecting or determining its absorption band need not be recited in the claim. This is also applicable to claims 12, 14 and 19.

Hence, for at least the reasons stated above, applicants respectfully submit that these rejections of claims 1, 4, 7, 12, 14, and 19 should be withdrawn.

**Rejection of Claims 1-20 Under 35 U.S.C. §102(b)**

In the May 22, 2003 Office Action, claims 1-20 were rejected under 35 U.S.C. §102(b) as being anticipated by Okazaki. Applicants respectfully submit that independent claims 1 and 4, and the claims which depend therefrom, are in no way disclosed by Okazaki for at least the reasons provided below.

In order to render a claim anticipated under 35 U.S.C. § 102, a single prior art reference must disclose each and every element of the claim in exactly the same way. *See Lindeman Machinenfabrik v. Am Hoist and Derrick*, 730 F.2d 1452, 1458 (Fed. Cir. 1984); *see also* M.P.E.P. §§706.02 and 2131; *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1989) ("The identical invention must be shown in as complete detail as is contained in the . . . claim.")

Claim 1 specifies a semiconductor-laser-excited solid-state laser apparatus, which includes *inter alia*, a solid-state-laser element and a semiconductor laser unit having

an internal resonator, the internal resonator having a length of at least 0.8 mm, the length of the internal resonator being dependent upon a characteristic of the solid-state laser element. Support for the corresponding claim language can be found, e.g., on page 5, lines 17-24, and page 14, lines 8-13. Additional support for the language of Claim 1 can be found throughout the specification and figures, e.g., Figs. 1-3.

Okazaki does not disclose a semiconductor laser unit that includes an internal resonator having a length of at least 0.8 mm, where its length is dependent on a characteristic of the solid-state laser element. Indeed, Okazaki describes a laser-style-pumped solid state laser, which includes a phased array laser 11 emitting a laser beam 10 as a pumping light beam, a focusing lens 12, a solid-state laser medium 13, a pair of resonator mirrors 14 and 15 disposed in front and rear of the solid state medium 13, a non-linear optical material crystal 16 disposed between the solid-state medium 13 and the resonator mirror 14, etalon 17 disposed between the solid-state laser medium 13 and the non-linear optical material crystal 16, and a pair of quarter-wave plates 18 and 19 respectively disposed in front and rear of the solid-state medium 13 between the resonator mirrors 14 and 15. The phased array laser 11 is kept at a predetermined temperature by a Peltier element and a temperature control circuit which are not shown. (Column 3, lines 3 – 23; *see also* Ohtsuka Declaration, page 4, ¶13).

The solid-state laser of Okazaki is of a type in which a solid-state laser medium is pumped with a pumping source and is characterized by having a wavelength selector element such as an etalon disposed in a laser resonator and a twisting means which makes a mode of an oscillating beam a twisted mode in the laser resonator. The primary object of the '240 patent was to provide a solid-state laser which is a longitudinal single

mode in the oscillation mode and has a high output power. (Column 1, lines 51 – 54; *see also* Ohtsuka Declaration, pages 4-5, ¶14).

Okazaki '240 does <u>not</u> describe or depict, in words or figures, an internal resonator in semiconductor laser unit 11. Accordingly, Okazaki is entirely silent about the length of an internal resonator in a semiconductor laser unit for emitting a laser beam to excite the solid-state laser unit. Thus, Okazaki teaches nothing about such internal resonator in the semiconductor laser source having a length of at least 0.8 mm. In addition, Okazaki teaches nothing about such internal resonator having a length depend on any characteristic of the solid-state laser. *See* Ohtsuka Declaration, page 5, ¶15.

The inventors unexpectedly determined that if the semiconductor-laser-excited solid-state laser apparatus was constructed with a solid-state laser element <u>and</u> a semiconductor laser unit having an internal resonator of specific proportions, namely, being at least 0.8 millimeters, and having a length that depends upon a characteristic of the solid-state laser element, the laser apparatus would have advantageous benefits. In particular, the dependence of the oscillation wavelength of the semiconductor laser unit on the driving current could be remarkably reduced. (Ohtsuka Declaration, pages 5-6, ¶17; *see also* Application, page 6, lines 10-13).

This resulted in a stable laser output from the semiconductor-laser-excited solid-state laser apparatus. Additionally, the operating current density of the semiconductor laser unit could be reduced, thus minimizing any damage to the light-emitting portion of the laser unit. This, in turn, increased reliability of the semiconductor-laser-excited solid-state laser apparatus. (Ohtsuka Declaration, page 6, ¶18; *see also* Application, page 6, line 2-Page 7, line 4).

The inventors have determined that the length of the internal resonator has an important unexpected benefit on the output of the laser apparatus. Referring to Figure 2, relationships between the second harmonic wave output of the laser apparatus and the output power of the semiconductor laser unit when the resonator lengths in the semiconductor laser unit are respectively 0.5 mm, 0.75 mm, 1 mm, 1.5 mm, 2 mm, and 3 mm, are illustrated. The curve b of Figure 2 illustrates this relationship in the conventional semiconductor-laser-excited solid-state laser apparatus, in which the resonator length in the semiconductor laser unit is 0.75 millimeters. When the output power of the semiconductor laser unit was increased by 10% from 2.0 watts to 2.2 watts, the increase in the second harmonic wave output was only 4%. In other words, the solid-state laser was not efficiently excited by the semiconductor laser unit having the 0.75 millimeters long resonator. (Ohtsuka Declaration, page 6, ¶19; *see also* Application, page 12, lines 1-14).

However, when the length of the internal resonator was increased to 1.5 millimeters, as illustrated by the curve d in Figure 2, the second harmonic wave output of the laser apparatus was unexpectedly increased by 8% with 10% increase in the output power of the semiconductor laser unit. (Ohtsuka Declaration, page 6, ¶20; *see also* Application, page 12, lines 15-25).

Furthermore, the inventors have determined that the length of the internal resonator affected the stability of the laser output at high powers. With a laser apparatus arrangement according to the present invention, it is possible to maintain the wavelength shift values within the width of the absorption band of the solid-state laser element, and obtain a stable, high-power, laser output, as illustrated in Figure 3. (Ohtsuka Declaration, page 7, ¶21; *see also* Application, page 14, lines 1-19).

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Amendment dated November 21, 2003
Response to Office Action of May 22, 2003

This is not taught or suggested in Okazaki '240 patent, which does not describe any length of an internal resonator in semiconductor laser 11. As previously described, only the external resonators have been described in this patent. *See* Ohtsuka Declaration, page 7, ¶22.

Hence, Okazaki fails to disclose <u>all</u> the claim limitations of Claim 1, as required to establish a *prima facie* case of anticipation.

Applicants respectfully submit that the outstanding rejections have been addressed and are overcome. Applicants further submit that all claims pending in this application are patentable over the prior art. Favorable reconsideration and withdrawal of those rejections and prompt allowance of the pending claims is respectfully requested.

If there are any questions, or if additional information is required, please contact Applicants' attorney at the number listed below. Any additional fees or charges required at this time and in connection with the present application are hereby authorized to be charged to Deposit Account No. 19-4709.

Respectfully submitted,

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## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Docket No.
699866/034
MWS:dc

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| Applicants | : | Hisashi Ohtsuka et al. | | |
| Serial Number | : | 09/552,540 | Art Unit: | 2828 |
| Filed | : | April 19, 2000 | Examiner: | A. Rodriguez |
| For | : | SOLID STATE LASER APPARATUS EXCITED BY LASER LIGHT FROM SEMICONDUCTOR UNIT HAVING INCREASED RESONATOR LENGTH | | |

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

## DECLARATION UNDER 37 C.F.R. §1.132

I, Hisashi Ohtsuka, declare the following:

1. I am an inventor of the subject application and am employed by the assignee thereof. I am fully familiar with the application, the Office Action dated May 22, 2003, and the reference cited therein. This Declaration is intended to form part of a response to the May 22, 2003 Office Action.

2. The present invention relates to a semiconductor-laser-excited solid-state laser apparatus, in which a solid-state laser element is excited by light emitted from a semiconductor laser unit used as an excitation light source. Prior to our invention, as more specifically described in the application, there were demands for increase in output power and improvement in quality of solid-state laser apparati. (Page 1, lines 13 – 15).

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3. A conventional response to these demands was to use a solid-state laser apparatus with a broad-guide semiconductor laser unit having a high power output. Additionally, as a widespread technique, the laser light was converted into a second harmonic wave by providing a wavelength conversion element in an external resonator arranged outside of the solid-state laser element. (Page 1, line 13, Page 2, line 2).

4. Similarly, in the conventional semiconductor-laser-excited solid-state laser apparati, the excitational light source was driven under a so-called automatic power control (APC), so as to stabilize the laser oscillation. In other words, a portion of output laser light was monitored and fed back to the excitational light source, so as to reduce the variations in the output laser light. (Page 2, lines 3-10).

5. In order to stabilize the output laser light by the automatic power control, it was desirable to have a constant ratio of an increase in the output of the semiconductor laser unit to an increase in the output of the solid-state laser apparatus. In other words, it was desirable that the output of the solid-state laser apparatus monotonously increases with the increase in the output of the semiconductor laser unit. (Page 2, lines 10 - 17).

6. However, in practice, the output of the solid-state laser apparatus did not monotonously increase, even when the output of the semiconductor laser unit was increased by 10% or 20%. (Page 2, lines 18-21). Indeed, the output of the conventional solid-state laser apparatus reached a level of saturation when the output of the semiconductor laser unit was increased by 8% over an initial driving state. (Page 2, lines 21- 25).

7. The above problem was caused in part by deviation in the oscillation wavelength of the semiconductor laser unit from a desired absorption peak of the solid-state laser element. Since a great amount of heat was generated by the semiconductor laser unit, the oscillation

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wavelength of the semiconductor laser unit was highly dependent on the driving current. (Page 3, lines 1- 6). In other words, the oscillation wavelength of the semiconductor laser unit shifted with an increase in the driving current. Consequently, the deviation of the oscillation wavelength of the conventional semiconductor laser unit from the desired absorption peak of the solid-state laser element increased with an increase in the driving current. Hence, the excitational light could not be efficiently absorbed by the solid-state laser element, and therefore, even when the driving current was greatly increased, the increase in the output power of the conventional solid-state laser apparatus was often small.

8. Some in the field have attempted to suppress the dependence of the laser unit's oscillation wavelength on the driving current by enhancing the radiation effect of the semiconductor laser unit. (Page 4, lines 6-11). In particular, an attempt has been made to optimize a mechanical member which fixes a semiconductor laser unit so as to enhance radiation efficiency and reduce the dependence of the laser unit's oscillation wavelength on the driving current.

9. However, this optimization of the mechanical member was insufficient to reduce the dependence of the oscillation wavelength on the driving current at increased output powers. (Page 4, lines 19-24).

10. Even the attempts to prevent the deviation of the oscillation wavelength did not fundamentally improve the characteristics of the semiconductor laser apparatus. Therefore, output loss was occurring in the solid-state laser apparatus, thus preventing further increase of the output power. Hence, attempts in the past suffered from a common drawback in that they did not provide a semiconductor-laser-excited solid-state laser apparatus in which stable automatic power control could be performed, and from which stable, high-power, laser light was output.

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11. Drawbacks with prior laser devices were overcome by providing a semiconductor-laser-excited solid-state laser apparatus according to the present invention, which included a solid-state laser element and a semiconductor laser unit with an internal resonator of specific length. (Page 5, lines 17 – 20). The resonator length in the semi-conductor laser unit, according to Claim 1 of the present invention, was arranged to be at least 0.8 millimeters, which is longer than the lengths of the conventional internal resonators. Furthermore, the actual length is dependent on a characteristic of the solid-state laser element used in the laser apparatus as discussed more fully in the application.

12. The invention is not merely a laser unit with an internal resonator. Rather, it is a laser apparatus with a laser unit that includes an internal resonator having certain properties as specified in the claims.

13. U.S. Pat. No. 5,671,240 to Okazaki describes a laser-style-pumped solid state laser, which includes a phased array laser 11 emitting a laser beam 10 as a pumping light beam, a focusing lens 12, a solid-state laser medium 13, a pair of resonator mirrors 14 and 15 disposed in front and rear of the solid state medium 13, a non-linear optical material crystal 16 disposed between the solid-state medium 13 and the resonator mirror 14, etalon 17 disposed between the solid-state laser medium 13 and the non-linear optical material crystal 16, and a pair of quarter-wave plates 18 and 19 respectively disposed in front and rear of the solid-state medium 13 between the resonator mirrors 14 and 15. The phased array laser 11 is kept at a predetermined temperature by a Peltier element and a temperature control circuit which are not shown. (Column 3, lines 3 – 23).

14. The solid-state laser of Okazaki is of a type in which a solid-state laser medium is pumped with a pumping source and is characterized by having a wavelength selector element

such as an etalon disposed in a laser resonator and a twisting means which makes a mode of an oscillating beam a twisted mode in the laser resonator. The primary object of the '240 patent was to provide a solid-state laser which is a longitudinal single mode in the oscillation mode and has a high output power. (Column 1, lines 51 – 54).

15. Okazaki '240 does not describe or depict, in words or figures, an internal resonator in semiconductor laser unit 11. Accordingly, Okazaki is entirely silent about the length of an internal resonator in a semiconductor laser unit for emitting a laser beam to excite the solid state laser unit. Thus, Okazaki teaches nothing about such internal resonator in the semiconductor laser source having a length of at least 0.8 mm. In addition, Okazaki teaches nothing about such internal resonator having a length depend on any characteristic of the solid state laser.

16. Okazaki only describes the internal components of the resonator of the solid-state laser, not those of the semiconductor laser used to excite the solid state laser, which is formed by the quarter-wave plate 18 and the resonator mirror 14, and is external to the semiconductor laser 11. (Column 5, lines 35 – 37). The solid-state laser described and depicted in Okazaki is not the semiconductor laser used to excite the solid-state laser apparatus. Okazaki's solid state laser is entirely different from the semiconductor laser with an internal resonator recited in the claim.

17. The inventors, unexpectedly determined that if the semiconductor-laser-excited solid-state laser apparatus is constructed with a solid-state laser element and a semiconductor laser unit having an internal resonator of specific proportions, namely, being at least 0.8 millimeters, and having a length that depends upon a characteristic of the solid-state laser element, the laser apparatus would have advantageous benefits. In particular, the dependence of

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the oscillation wavelength of the semiconductor laser unit on the driving current could be remarkably reduced. (Page 6, lines 10-13).

18. This resulted in a stable laser output from the semiconductor-laser-excited solid-state laser apparatus. Additionally, the operating current density of the semiconductor laser unit could be reduced, thus minimizing any damage to the light emitting portion of the laser unit. This, in turn, increased reliability of the semiconductor-laser-excited solid-state laser apparatus. (Page 6, line 2-Page 7, line 4).

19. We determined that the length of the internal resonator has an important effect on the output of the laser apparatus. Referring to Figure 2, relationships between the second harmonic wave output of the laser apparatus and the output power of the semiconductor laser unit when the resonator lengths in the semiconductor laser unit are respectively 0.5 mm, 0.75 mm, 1 mm, 1.5 mm, 2 mm, and 3 mms, are illustrated. The curve b of Figure 2 illustrates this relationship in the conventional semiconductor-laser-excited solid-state laser apparatus, in which the resonator length in the semiconductor laser unit is 0.75 millimeters. When the output power of the semiconductor laser unit is increased by 10% from 2.0 watts to 2.2 watts, the increase in the second harmonic wave output is only 4%. In other words, the solid-state laser was not efficiently excited by the semiconductor laser unit having the 0.75 millimeters long resonator. (Page 12, lines 1-14).

20. However, when the length of the internal resonator is increased to 1.5 millimeters, as illustrated by the curve d in Figure 2, the second harmonic wave output of the laser apparatus is increased by 8% with 10% increase in the output power of the semiconductor laser unit. (Page 12, lines 15-25).

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21. Furthermore, we determined that the length of the internal resonator affected the stability of the laser output at high powers. With a laser apparatus arrangement according to the present invention, it is possible to maintain the wavelength shift values within the width of the absorption band of the solid-state laser element, and obtain a stable, high-power, laser output, as illustrated in Figure 3. (Page 14, lines 1-19).

22. This is not taught or suggested in Okazaki '240 patent, which does not describe any length of an internal resonator in semiconductor laser 11. As previously described, only the external resonators have been described in this patent.

23. Laser units with conventional internal resonators, but not in combination with semiconductor elements as claimed, are known. For example, Exhibit 1 is an article describing a conventional laser unit with an internal resonator.

24. Furthermore, the specific construction of the internal resonator and its structure are not essential to the claimed invention. "Essential Material" is defined as that which is necessary to (1) describe the claimed invention, (2) provide an enabling disclosure of the claimed invention, or (3) describe the best mode. M.P.E.P. 608.01 (P)(I)(A).

25. It would be known to those of ordinary skill in the laser arts how to make the conventional internal resonator used in a laser unit. Therefore, it would be known to make such a device as specified in the claims and include it in the claimed system. Hence, it is not necessary to describe the internal structure of a particular resonator.

26. However, what would not be known is to use a semiconductor laser source with an internal resonator having a length of at least 0.8 mm, the length of which is dependant on characteristics of the solid state laser it is used to excite. Nevertheless, the characteristics of the internal resonator according to the present invention are sufficiently described so as to enable

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those of ordinary skill in the art to practice the invention. (See, e.g., p. 11, line 25-p. 14, line 19, and corresponding Figs. 2 and 3). As previously pointed out, the internal resonator in the laser apparatus according to Claim 1 of the present invention is characterized as having the length of at least 0.8 mm, the length being dependant on a characteristic of the laser element used in the apparatus.

27. In view of the foregoing, it is submitted that the internal resonator and its structure need not have been defined and depicted since it would be known how to make such an internal resonator and the novel characteristics according to the present invention are sufficiently described in the specification.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Hisashi Ohtsuka
Hisashi Ohtsuka

Dated: November 19, 2003